Enhanced Land Cover and Land Cover Change Products from MODIS

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Land cover product

l Current product planned for production by MODIS is Land cover data set based on multispectral and multitemporal data is planned from MODIS using a neural net approach Strahler

l Our proposals will enhance this product by :

 » making an at launch product available using AVHRR data

 » by creation of additional planes of land cover characterizations depicting continuous fields all based on the AVHRR sensor's data.

Benefits for EOS from proposal

l   A product specifically focused on land cover change relevant to local and regional studies as well as global ones: in particular we anticipate the product to have considerable value for users such as natural resource managers

l   An improved MODIS land cover product as a result of the use of the 250m product proposed and application of novel image processing procedures we have been developing..

l   Land cover change results from EOS a short-time after launch, instead of during the second year after launch.

l   A product which can assist the optimization of the acquisition strategies of Landsat 7 and other fine resolution systems. This should lead to improved use of such sensors and improve the availability of data for those working at more local scales.

Land cover change

l   Currently it is planned that land cover change will be detected by comparison of temporal curves using a procedure known as change-vector analysis (Lambin et al. 1994).

l   We propose methods for the selective use of the 250m bands to enhance change detection taking advantage of their finer spatial resolution.

Use of 250m bands

1 We propose therefore of products using the 250m bands for the following:

- – i)   to create two land cover change indicator products at a nominal resolution of   250m
- – ii)   using (i) provide data input which will improve the performance of the proposed MODIS 500m land cover product
- – iii) using (i) create an alarm system to assist the data acquisition strategies of fine resolution sensors such as Landsat 7.

Additional products

- – iv) an at-launch product at 1 km resolution, (based if available on analysis of the version 2 global 1km AVHRR data set).

- – v) research products at 500m and 250m from MODIS data in which land cover is depicted as fields of continuous properties

Two-date procedure for change detection

l   Many changes which occur within scenes are unrelated to actual land cover changes and hence it is necessary to identify a thresholds of spectral response beyond which "true" changes actually occur.

l   One possibility is to use the minimum size of the thresholds VIth and Rth needed to detect the occurrence of cover change.

l   Six basic types of change can be conceptually identified, namely where VIth or Rth will be exceeded during either an increase or decrease from time 1 to time 2 and where both thresholds are exceeded.

l   May be necessary to vary the size of the threshold according to the absolute size of the value of the vegetation index

Two-date change detection

l   Many of the changes which may be observed may simply arise
    due to phenological changes. Hence we will investigate the use
    of changes in values of the vegetation index and brightness in
    excess of the mean changes within a window of dimensions W
    surrounding each pixel.

l   Regional models and typologies will be developed by the
    proposed team member and current collaborators in a number
    of projects including:

    » i) tropical deforestation and regrowth in the Pan-Amazon and
        Central Africa.

    » ii) savanna dynamics in east and sahelian Africa,

    » iii) boreal forest dynamics in Canada,

    » iv) desert boundary changes in central Asia and northern Africa,

    » v) temperate forest and agricultural change in the United States,

    » vi) coastal wetland change in the eastern United States.

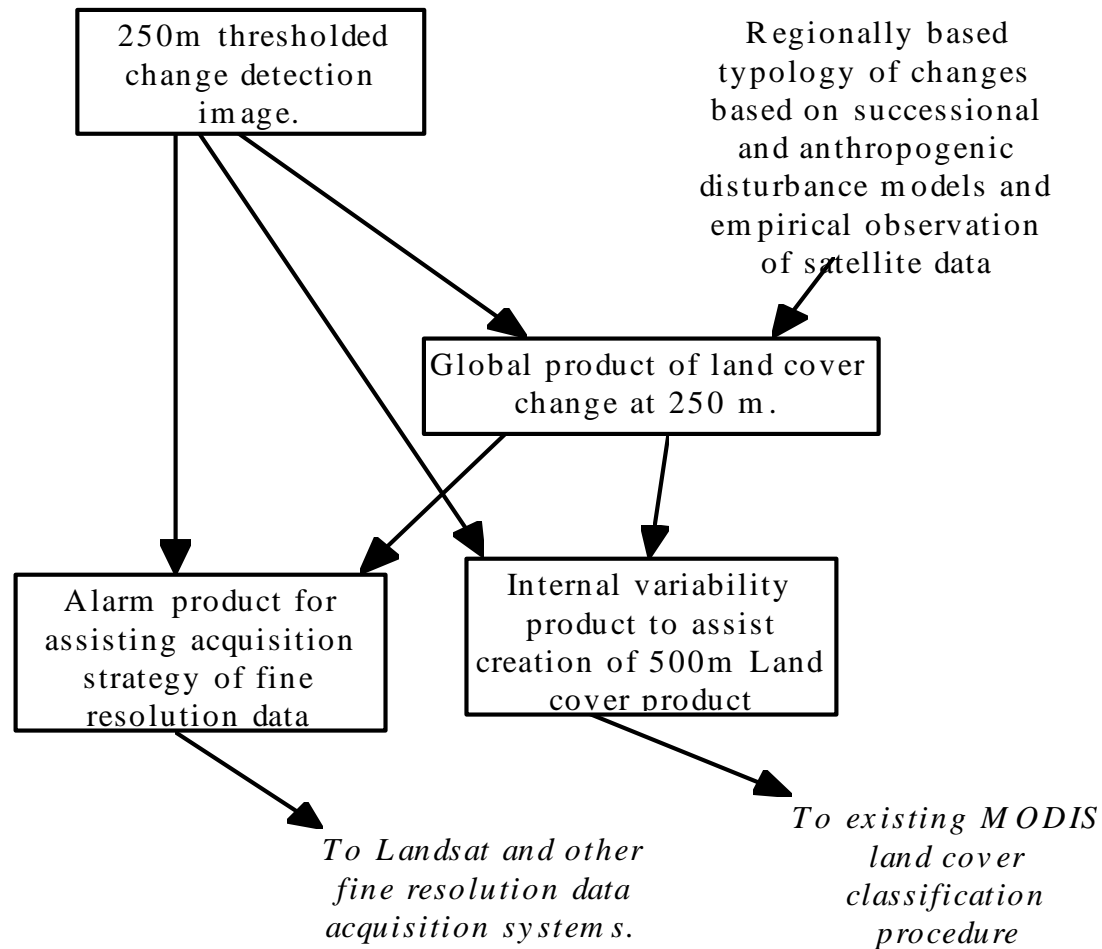# Thresholds in greenness-albedo space

1

Greenness

Th_B

Th_B

1

5

Th_G

2

6

4

3

Albedo
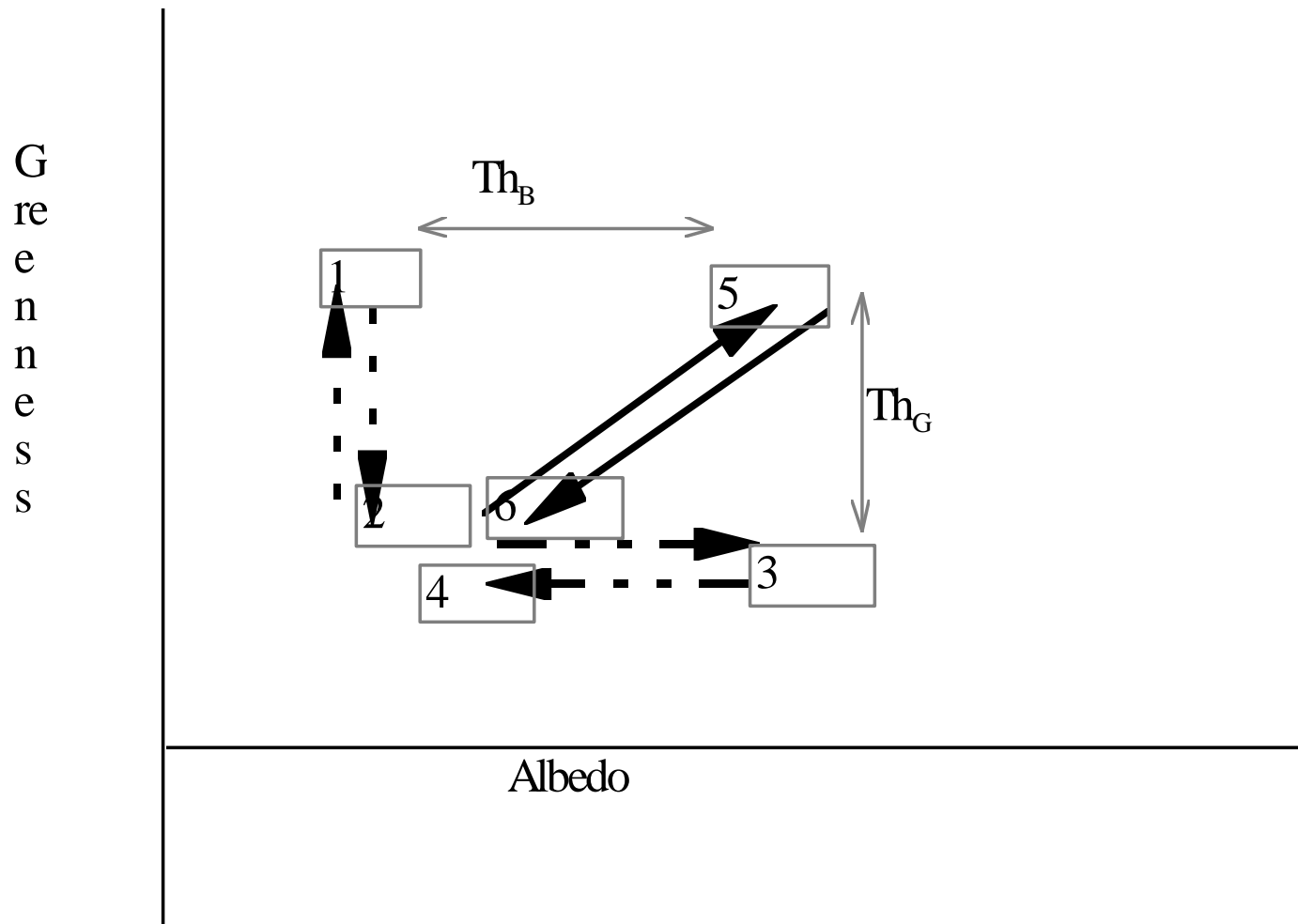
Multi-date procedure

l   Procedures used in the multi-date approach will follow fundamentally the same approach as that used in the dual-date approach, but the threshold of changes will be also carried out relative to the annual phenological cycle of greenness displayed by vegetation indices when plotted against time e.g., (Justice et al. 1985).

l   Once more than a year's data have been obtained we will then use deviations from the seasonal vegetation index temporal profiles to assess whether the threshold has been exceeded indicating a land cover change.

l   Consideration of the observed pixel changes relative to changes in surrounding pixel values should also be included in the decision rule, as proposed for the dual date approach, since otherwise many of the flagged changes in land cover will relate merely to local and regional phenological variations

Change detection products (indicated in boxes) with outputs to other parts of MODIS and EOS.

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| 250m thresholded change detection image. |

| Regionally based typology of changes based on successional and anthropogenic disturbance models and empirical observation of satellite data |

| Global product of land cover change at 250 m. |

| Alarm product for assisting acquisition strategy of fine resolution data |

| Internal variability product to assist creation of 500m Land cover product |

To Landsat and other fine resolution data acquisition systems.
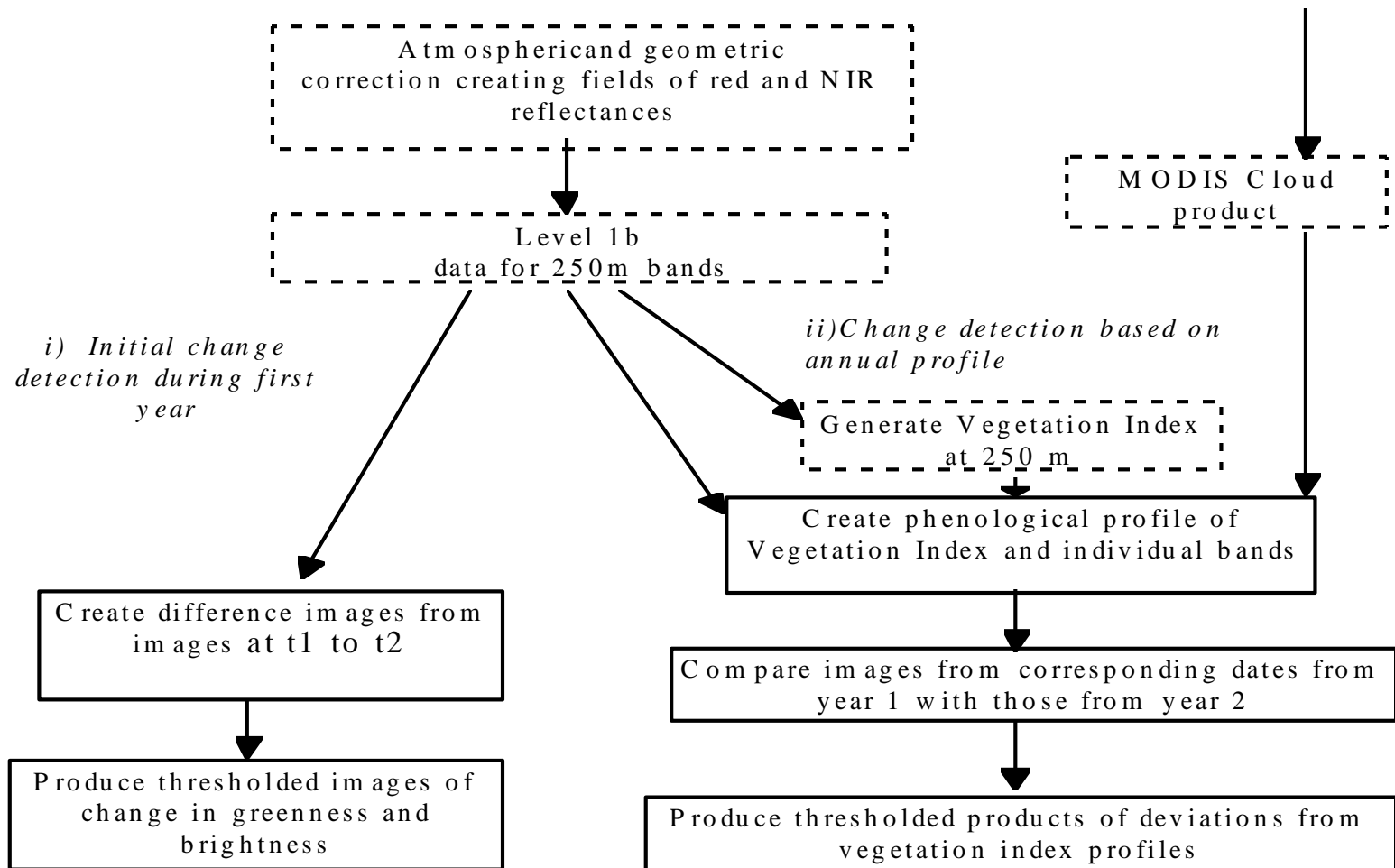
To existing MODIS land cover classification procedure

Schematic of the processing chain for the land cover change indicator products.
(Dashed boxes indicate existing MODIS products)

1

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┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┐
   Atmosphericand geometric
   correction creating fields of red and NIR
   reflectances
└ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┘
```

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┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┐
   MODIS Cloud
   product
└ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┘
```

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┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┐
   Level 1b
   data for 250m bands
└ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┘
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i) Initial change detection during first year

ii)Change detection based on annual profile

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┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┐
   Generate Vegetation Index
   at 250 m
└ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┘
```

```
┌─────────────────────────────────┐
│ Create phenological profile of  │
│ Vegetation Index and individual bands │
└─────────────────────────────────┘
```

```
┌─────────────────────────────────┐
│ Create difference images from   │
│ images at t1 to t2              │
└─────────────────────────────────┘
```

```
┌─────────────────────────────────────┐
│ Compare images from corresponding dates from │
│ year 1 with those from year 2       │
└─────────────────────────────────────┘
```

```
┌─────────────────────────────────┐
│ Produce thresholded images of   │
│ change in greenness and         │
│ brightness                      │
└─────────────────────────────────┘
```

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┌─────────────────────────────────────┐
│ Produce thresholded products of deviations from │
│ vegetation index profiles       │
└─────────────────────────────────────┘
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At-launch land cover products

l   As part of our NASA funded Global Land Cover Classification project we are using training sites developed from analysis of existing ground based maps and fine resolution satellite data to produce land cover classifications of the globe. One product generated at a resolution of one degree is the land cover class product which is published on the ISLSCP CD-ROM.

l   Using our existing methods and training data we are currently generating a product at 8 km using the AVHRR Land Pathfinder Version 1 data set.

l   We further intend to generate a land cover product at 1km using the USGS/NASA/NOAA/IGBP-global AVHRR data set using current funding from NASA. This is offered as a contribution to an at-launch MODIS product and we will work to convert this or other at-launch data sets of land cover into forms needed to support other MODIS products.

Representation of land cover by continuous fields data.

1   Instead of the conventional land cover classifications, recent work at the University of Maryland has shown great promise for the creation of products of continuous attributes of vegetation components such as the proportions of tree cover, bare ground and the herbaceous layer by use of methods such as empirical regressions, decision-tree procedures and mixture modelling (Defries et al. 1994; Defries et al. 1995).

1   We propose to apply these methods initially to the version-1 1km AVHRR global data set and subsequently to version 2 data sets as they become available and to make these representations of vegetation properties available as at-launch products.

Representation of land cover by continuous fields using MODIS data.

l   Above methods will be applied to MODIS data to create post-launch products of land cover as represented by continuous fields rather than traditional classes.

l   Such data should yield considerably improved products compared with those obtained with AVHRR data, because of the removal of atmospheric effects and because of the higher spectral dimensionality of the MODIS data sets compared with the AVHRR.

Validation and Training

l   i) Use of an in-house data base of fine resolution data sets from Landsat

l   ii) Involvement in major cooperative validation efforts especially the IGBP Land Cover Working Group validation effort and the Global Terrestrial Observing System (GTOS). Assistance in validation will be contributed though the team member's involvement in the IGBP-DIS Land Cover Working Group, and the Landsat Test Site Activity which is building up land cover data from sites throughout the world.

l   iii) Reliance on the expertise of existing collaborators

Summary of land cover products proposed and their contribution.

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1 km resolution data land cover product	Land cover change indicator product at 250m resolution	Land cover change indicator product based on phenological change at 250m resolution.
a) set of land cover components e.g % tree cover	*(Will also be used to create Fine resolution sensor land cover alarm product and to assist existing land cover classification)*	
b) conventional 1km land cover product based on supervised classification		**Land cover components** @500m and 250m